

APRIL/MAY 2025

GMA42/DMA42 — FLUID DYNAMICS

Time : Three hours

Maximum : 75 marks



SECTION A — (10 × 2 = 20 marks)

Answer ALL questions.

1. Define vorticity vector.
2. Define real and ideal fluids.
3. Define Venturi tube.
4. Write the Eulers equation of motion in tensor form.
5. Define doublet.
6. Write the Stokes stream function.
7. Define line sources.
8. Define line vortices.
9. Define normal and shearing stress.
10. Define coefficient of viscosity.

S is θ immediately drops to $pga\left(\sin\theta - \frac{2\theta}{\pi}\right)$

above atmospheric pressure prove further that when the liquid remaining in the tube subtends

an angle β at the center, $\frac{d^2\beta}{dt^2} = -\frac{2g}{\alpha\beta}\sin^2\left(\frac{\beta}{2}\right)$.

18. Prove that the velocity potential at a point P due to a uniform finite line source AB of strength m per unit length is of the form $\phi = m \log f$, where

$$f = \frac{r_2 + x_2}{r_1 + x_1} = \frac{r_1 + x_2}{r_1 + x_1} = \frac{a + l}{a - l} \quad \text{in which } AB = 2l,$$

$PA = r_1$, $PB = r_2$, $NA = x_1$, $NB = x_2$ N being the foot of the perpendicular from P on the line AB , and $2a$ the length of the major axis of the spheroid through P having A, B as foci. Show that the velocity at P is $(2ml \cos \alpha) / (a^2 - l^2) u$, where u is the unit vector along the normal to the spheroid $2\alpha = \angle APB$..

19. State and prove Milne-Thomson Circle theorem.
20. Derive Navier stokes equation of motion of a fluid.

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions.

11. (a) Derive the acceleration of fluid particle.

Or

- (b) Discuss about the equation of continuity.

12. (a) Derive the Eulers equation of motion.

Or

- (b) Derive the Bernoulli's equation.

13. (a) Explain the images in a rigid infinite plane.

Or

- (b) Discuss doublet in a uniform stream.

14. (a) Find the equation of the streamlines due to a uniform line sources of strength m through the points $A(-c, 0)$ and $B(c, 0)$ and a uniform line sink of strength $2m$ through the origin.

Or

- (b) Discuss the flow due to a uniform line doublet at O of strength μ per unit length, its axis being along $\overline{OX}$.

15. (a) Derive the translational motion of fluid element.

Or

- (b) Explain stress analysis in fluid motion.

SECTION C — (3 × 10 = 30 marks)

Answer any THREE questions.

16. Test whether the motion specified by

$$q = k^2 \frac{x\vec{j} - y\vec{i}}{x^2 + y^2} k = \text{constant},$$

is a possible motion for an incompressible fluid. If so determine the equation of the stream line and also test whether the motion is the potential kind and so determine the velocity potential.

17. AB is a tube of small uniform bore forming a quadrantal arc of a circle of radius a and centre O , OA being horizontal and OB being vertical with ρ below O . The tube is full of liquid of density ρ , the end B being closed. If B is suddenly opened, show that initially $\frac{du}{dt} = \frac{2g}{\pi}$, where $u = u(t)$ is the velocity, and that the pressure at a point whose angular distance from